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VALUE ENGINEERING:
INTENSIFIED COST REDUCTION

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VALUE ENGINEERING - INTENSIFIED COST REDUCTION

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1948

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A thesis submitted to the faculty of the School of Government, Business and International Affairs of the George Washington University in partial satisfaction of the requirements for the degree of Master of Business Administration.

June 6, 1962

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INTRODUCTION

The military has felt, with increasing pressure each passing year, the squeeze of mounting costs for more complex equipments matched against a relatively fixed allocation of funds. This continuous rise in prices generated increasing concern within the Navy Department in the early 1950's. Action was taken to survey industry cost reduction efforts to find an effective continuing technique that might be used as a model within the Navy. The value analysis program at the General Electric Company appeared to be a unique effort of quite some achievement and promise, and after considerable study, was adopted by the Navy and has become identified as value engineering.

The value engineering philosophy, within the Navy, has grown rapidly since adoption to its present state of acceptance. Many persons believe it is now ready to be used as one of the best solutions to the many problems our various supply managements are confronted with, particularly in respect to the problem of obtaining the maximum return from each and every appropriated dollar. However, it is not difficult to find those who believe that this new art or technique of value engineering is nothing more than a new name applied to a method of analyzing a problem that every cost-conscious person normally uses every day in the week. These same people feel that continued emphasis on the value engineering program is just so much additional waste of time and money.

The lack of a commonly accepted definition as to just what is meant by value engineering has generated some heated arguments between proponents and opponents of this technique. Some of the persons engaged in the field feel that the term value engineering should only be used to denote value work "before the fact", i.e., before design release, and that the term value

analysis should be used for "after the fact" work. Others feel that the terms value analysis and value engineering should be used synonymously and for the purposes of this paper, they have been so used.

Regardless of the definition of the term value engineering, it appears to be a technique that holds significant promise as a management tool which could assist in the elimination of waste and duplication in the area of supply management. Based on these qualifications, it behooves each and every person in the Navy to become familiar with the basic concepts and applications of value engineering.

This paper is an attempt to set forth the basic concept of value engineering and how it has been applied in the Navy. It is hoped it will provide a convenient source of information and reference that may be used by other persons interested in the vital area of cost reduction.

CHAPTER I

CONCEPT

> Dollars are the best measure of manpower, material and efforts. The Navy will not buy if the value is not good.... The producer who reduces his costs is the one who will survive.[1]

There seems to be a great deal of confusion about exactly what is meant by value engineering. A review of some of the various comments made by proponents and practitioners of this technique makes it rather clear that "value engineering" means different things to different people. Because such programs, if they are to be successful, must be adapted to the needs and facilities of the individual company, it is easy to see that substantial differences will appear.

Value engineering has been defined as a creative study of every item of cost in every part or material we use.[2] It is a philosophy, and a system of techniques now being used as a scientific method of operation that promises to go far beyond anything we have ever known before in finding unnecessary costs and eliminating them. Another definition expresses value engineering as an objective appraisal of all elements of the design, construction, procurement, installation and maintenance of an equipment, including the applicable equipment specifications, in order to achieve the necessary functions, maintainability and reliability of an equipment at minimum cost.[3] The simplest and most pointed definition of value engineering states that it is

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[1]Thomas S. Gates, Former Secretary of the Navy, Value Engineering 1959, Engineering Publishers, Elizabeth, New Jersey, p. 85.

[2]Value Engineering Program, Plant Management and Maintenance Co., Haddonfield, New Jersey, p. 20-2.

[3]Product Engineering, McGraw-Hill Publishing Co., Inc., 15 May 1961, p. 6.

an organized approach to the problem of getting more for our money.[4] L. D. Miles, General Electric's Manager of Value Analysis Service, often referred to as the Dean of Value Engineering, sets forth the most commonly accepted definition as follows:

> Value Engineering is a philosophy implemented by the use of a specific set of techniques, a body of knowledge, and a group of learned skills. It is an organized creative approach which has for its purpose, the efficient identification of unnecessary cost.[5]

Some people often refer to value engineering as just another phase of a manufacturing or engineering cost reduction plan. This does not seem to be true, as value engineering is more of a supplement. It materially assists in improving the effectiveness of work being done in the manufacturing or engineering programs by fostering closer relationships, cooperation, and better teamwork between such sections.

Just What is Value?

Value means a great many things to a great many people because the term value is used in a variety of ways. Most frequently it is confused with cost and with price. In most cases, value to a producer means something different from value to a user. Furthermore, the same item may have differing value to the customer depending upon the time, the place, and the use.

Value then must be considered as a broad term. It is often divided into four kinds which are set forth below; however, only the first two are useful in value studies:

Use Value: The properties and qualities which accomplish a use, work, or service.

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[4]U.S., Department of the Navy, Bureau of Supplies and Accounts, NAVSANDA PUBLICATION 396, 1 November 1961.

[5]Miles, Lawrence D., Techniques of Value Analysis and Engineering, New York: McGraw-Hill Book Company, Inc., 1961.

Esteem Value: The properties, features, or attractiveness which cause us to want to own it.

Cost Value: The sum of labor, material, and various other costs required to produce it.

Exchange Value: Its properties or qualities which enable us to exchange it for something else we want.[6]

Value is not inherent but is determined by a number of things. To be useful in identifying and eliminating unnecessary cost, value becomes a measure of the appropriateness of the costs involved. Value is often stated as the minimum dollars which must be expended in purchasing or manufacturing a product to create the appropriate use and esteem factors. Value of a product may be considered the appropriate cost to accomplish the use and to provide the proper esteem. Value engineering is concerned with use value as the lowest cost of providing for the reliable performance of a function and with esteem value as the lowest cost of providing the appearance, attractiveness, and features which the customer wants.[7]

Quite likely, miximum value is never achieved. The degree of value in any product depends on the effectiveness with which every usable idea, process, material, and approach to the problem have been identified, studied, and utilized. Therefore, we might conclude that the purpose of the special techniques and special knowledge of value engineering is to bring with less expenditure of time and cost, more of the better value combinations into focus.

In normal usage, value is considered good if a product contains somewhat better combinations of ideas, processes, materials, and functions,

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[6]Value Analysis, Schenectady, N.Y., Value Programs for Industry, Incl., 1960.

[7]Miles, op. cit., p. 3.

costwise, than its competition; it is considered bad if, because the opposite is true, lost sales volume results.[8] It seems readily apparent then that such a method of determining the degree of value comes too late and probably has serious limitations.

Who Contributes Performance and Value?

Every individual involved in the making of a product contributes toward attaining the performance needed, and each must also, in his own area, contribute to the value of the product. Beginning with the sales department, a representative of the company contacts a customer and, by some means, learns what this customer wishes to buy and is willing to pay to get it. By going beyond the act of merely taking orders and giving the customer the benefit of his knowledge and experience, the sales representative is in a position to do a great deal toward attaining suitable performance combined with attractive value.

The design engineer then provides geometry and detail for the proposed product. This establishes a means for attaining the predetermined use and esteem values. In this endeavor, more than one useful solution often times emerges before final selection. Decision making by the designer, therefore, requires much evaluation to arrive at the best combination of performance and value for the particular use.

Next, it becomes the task of the production engineer and the manufacturing expert to provide the tooling and facilities that will be most efficient for making the product. This takes an exhaustive review of both in-plant and outside equipment and practices to make a selection that will ensure the appropriate value content of the product. Usually this stage

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[8] Ibid., p. 4.

merges considerably with the previous stage so that the intended means of manufacture will be factored into design-detail decisions. Finally, the management of the shop which actually builds the product must give the fullest consideration to all the elements that enter into the cost of production. This includes the very substantial element of materials, and here the purchasing department usually has an opportunity to make a significant contribution toward attaining a better value status through various procurement methods.

The decisions of each of these various participants determine the degree to which a customer will be provided with the desired use and esteem values at the lowest cost. It seems apparent that unnecessary cost is identified only to the degree that these participants secure the best ideas, the best information, and the best utilization of value possibilities, each in his own area.

Value-oriented work at each stage of the product design and manufacturing cycle cannot be accurately measured.[9] Therefore, after what the individual considers a reasonable effort using the value tools and the time and information he has, decisions are made by judgment with respect to the manufacturing and engineering alternatives. Again it is seen that, if any of these decisions bring about poor performance, tests will show it. If, on the other hand, they bring poor value, there is no immediate way of making this evident. Consequently, performance-oriented work is normally more efficiently and effectively accomplished than value-oriented work.

Customer use values and customer esteem values should translate themselves into functions as far as a designer is concerned. The functions

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[9]Ibid., p. 5.

of the product which cause it to perform its use and to provide the esteem values wanted by customers can be clearly identified and distinctly divided into two categories. Both of these categories are of recognized importance and both enter into value engineering. Conversely, no cost should be included in the product without adding a function, either causing it to perform or causing it to sell. Where function consists of two parts -- that which causes the product to perform and that which causes it to sell -- the value in dollars becomes the lowest cost combination of design, materials, and process which will reliably accomplish these functions. Value in dollars can then be established by comparison, both for the composite of all functions and for each individual function.

It may be reasonably concluded then, that the main objective of value engineering is providing equivalent performance at lower cost, cost being related to the function, service, or operation purchased by that cost.

Basic Steps of Value Engineering

In the process of obtaining lower-cost engineering and manufacturing solutions and alternatives, three basic steps are used:

1. Identify the function.
2. Evaluate the function by comparison.
3. Cause value alternatives to be developed.[10]

A useful product or service must have a prime function. Such function is usually described by a two-word definition such as, provide light, pump water, or indicate time. In addition, there may be secondary functions involved. A light source may be required to resist shock, a pump for domestic use to operate at a low noise level, a clock or watch to provide attractiveness, an

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[10]Mandelkorn, R. S., Value Engineering 1961, Elizabeth, N.J.: Engineering Publishers, 1960, p. 9.

umbrella to be useful as a cane, a dust enclosure to allow access to interiors, and a handle support to provide for locking.

Once the functions have been determined and evaluated in terms of primary and secondary nature, the value engineer examines the cost of each with the aim of determining its appropriateness or of finding some other, lower-cost way of accomplishing that particular function. A basic ground rule in this connection is that the value engineer must accept the assumption that the device or part is in principle what is wanted to provide the function. Otherwise, he may go too far afield. This step of identifying the function is the value engineer's initial tool. In some cases, just the clear use of this step prompts ideas and information which result in much better value.

As was previously discussed, value requires a relative rather than an absolute measure and necessitates that a comparison approach be used in evaluating functions. The larger and more complicated an object undergoing analysis, the greater the number of comparisons necessary to make the analysis sufficiently comprehensive to establish the best value for each included function. This means analyzing a series of basic functions, each discovered by breaking the assembly down into its sub-units, components, and parts. In such a way the problem becomes one of comparing the use of one material with that of another, the style of one part with that of an equivalent, the application of one process of manufacture with that of another, and so on. It can be said almost without fear of contradiction that, if there is no comparison, there is no evaluation. All evaluation results from comparison of some kind: in some instances, comparison with standards; in other instances, comparison with similar items; and in still others, comparison with partially

similar items. If, in the pursuit of better value, functions have not been identified and these functions have not been evaluated by comparison, then the process has not been value analysis but merely cost analysis.

In developing value alternatives, realistic situations must be faced, objections overcome, and effective engineering, manufacturing, and other alternatives developed. Anyone engaging in value work must recognize that it is his responsibility and opportunity to begin at this point and, without unduly or unnecessarily ruffling human feelings, bring forth substantiating facts. This implies the use of techniques which will penetrate the subject further, in the direction of securing the desired functions for lower cost, and which will produce, in tangible form, information that may alter deep-seated beliefs - oft times erroneous - which govern decisions.

In the search for, and selection of, alternatives, the value engineer's attention must be constantly focused on function and not merely on material, part, or device as such. Unless this is done, it is easy to fall into the trap of considering an alternative that may impair the designed-in function and thus fail to meet the fundamental requirement of value analysis that the needed function must be accomplished reliably at the lowest cost.

Value Engineering Approach

The value engineering approach requires, first of all, that valid and complete answers be developed for the following five questions:

1. What is the item?
2. What does it cost?
3. What does it do?
4. What else would do the job?
5. What would that alternative cost?[11]

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[11]Miles, op. cit., p. 18.

These basic questions serve the end of uncovering needed pertinent facts. With the establishment of answers to them, the foundation is laid for developing objective data for presentation to the decision makers. Unless this phase of the work is effectively and penetratingly done, it cannot be hoped that the product will have more than an average degree of value.

The Value Engineering Techniques

Successful value engineering effort, resulting in the elimination of unnecessary cost, depends a great deal upon skillful application of techniques that will identify unnecessary cost, remove obstacles, and provide a course of action that will ensure the development of value alternatives of merit.

Such a series of techniques has been developed and has proved capable of meeting real-life situations. In some cases, good results are obtained by using only one of the techniques, but in many more cases, more than one is often applied. The situation in each particular instance will dictate whether one, several, or even a whole group of techniques holds the best promise.

The commonly accepted value engineering techniques are:

1. Avoid generalities.
2. Get all available costs.
3. Use information from only the best source.
4. Blast, create, refine.
5. Use real creativity.
6. Identify and overcome roadblocks.
7. Use industry specialists to extend specialized knowledge.
8. Get a dollar sign on key tolerances.
9. Utilize vendors' available functional products.
10. Utilize and pay for vendors' skills and knowledge.
11. Utilize specialty processes.
12. Utilize applicable standards.
13. Use the criterion, "Would I spend my money this way?"[12]

All too frequently a good idea or proposition is swept aside by a

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[12] Ibid., p. 36.

good-sounding generality such as, "The farm is no good -- never has been and never will be." Such general statements stop progress in somewhat the same way that fog stops traffic. Although there is not necessarily any tangible obstruction in a fog, as a dense, unmanageable curtain it constitutes a good stopper. The value engineer must avoid the generalities trap. He must recognize that if a generality exists, it has probably deferred effective value action in the past. He must proceed to break the situation down into specific, man-size integers of function and cost. Whenever the objective is to promote beneficial change, he must always use specifics. Generalities serve only to prevent changes and protect the status quo.

Meaningful costs bear the same relationship to good value as meaningful tests bear to good performance. Unfortunately, it is not uncommon to find that far-reaching and important decisions are made without accurate and meaningful costs. In contrast, important decisions affecting performance are no longer made without meaningful test data. To have available and use meaningful costs is more vital and more difficult than may be immediately apparent. It is vital because cost is influenced by every decision on every part, component, or subcomponent of a product. If meaningful cost is a criterion in each decision, then value may be secured, otherwise, value is not obtainable. Meaningful costs are difficult to develop because of the matter of overhead or burden. In practice, nearly every machine and nearly every process actually consumes a different overhead. Still, for convenience of accounting, they are bunched together in some sort of grouping. How should the fixed overhead for the buildings, the depreciation, and the management of the company be apportioned? How should the work of maintenance people, janitors, service people, etc., be factored into individual costs? What effect

on all of these expenses would different alternatives actually have?

The problem here lies in the fact that it is necessary to provide not only an answer which is satisfactory to the head of accounting or to the manager, but an answer which is also satisfactory to the economic system. An incorrect method of preparing so-called meaningful costs has been empirical and arbitrary. The tendency is to prolong the use of existing types of cost.

The purpose here is not to penetrate deeply into accounting practices--a subject in which many courses of instruction are available -- but rather to set forth the thought that the mere inclusion of overhead does not bring meaningful costs for value decisions. To prepare meaningful costs for the purpose of making correct value decisions, the true effect of the use of the different alternatives must be interpreted in terms of dollars for several areas. How is the business really affected? How is the product affected? How will sales be affected? How will other products be affected? How will the company's future plans be affected? How will the development of new technology be affected? Attainment of the desired degree of reliable performance is commonly no problem except in the case of newer products which are the result of recent research and development, and these might embrace 10 percent of the industrial production. Where the problem does lie is in getting reliable performance at low-enough cost. Cost is the important factor in decision making in every phase of product planning, designing, and manufacturing. For nearly every function and for nearly every manufacturing situation, there exist many alternative solutions, all of which will accomplish the purpose reliably. Proper selection depends upon meaningful costs, and only when such costs serve as an essential criterion in the decision making will good value be achieved. Without meaningful cost, decisions will not, and

cannot, be made to provide good value.

Lack of full information and use of misinformation are frequently the cause of a poor degree of value. In recognition of this, the search for pertinent information in value engineering must be a continuing one, and likewise, the sources from which the information comes must constantly be weighed to ensure that they constitute the best ones available. The more diligent and effective the search for the best information, the better the value attained. It always pays to locate and consult the best source.

Blast, create, and refine is a special technique usually helpful in reaching value objectives. Its purposes are many. First, it serves to eliminate what is in immediate view so that the mind is not longer channeled and so that thinking in totally different, more effective directions is not stifled. Second, it directs thinking to basic considerations. Third, it provides a mechanism for building that which is needed on these basic considerations.

The use of this technique is often very painful to the originator of a design or a plan. His solutions are his brain children, so to speak; in arriving at them, a great deal of effort was expended. Studies were made, money was spent, the aid of others was solicited, and so on. With the concept evolved and the plan integrated, the designed and manufactured product has truly become a part of the individual. To him, the idea of "blasting" is inwardly revolting. It is as though a part of his being were about to be destroyed.

In the technique, the function or functions are first brought into very clear focus. Then the possible means of providing the functions are reduced to oversimple terms. The necessary complexity is then added.

Alternative means for adding the complexity come next. Where good-grade value is required, this procedure is necessary to eliminate the causes of why things are done as they are. The common controlling factors are the habits and knowledge of the people at the time the particular thing, whatever it be, was first done and when it later was modified as different processes and materials and other people came into the picture.

The very useful value analysis technique of blasting, creating, and then refining serves first to bring the needed functions sharply into focus. Then the means being used or planned to accomplish these functiond are critically reviewed and blasted by comparing them with processes, products, or materials which would accomplish only part of the function but which would have a small fraction of the cost. This is followed by an extensive and intensive creative effort in which a series of significant alternatives for accomplishing the total function of each part of the function or for causing other methods to perform satisfactorily are brought into view. In a subsequent refining effort, the total needs for the application are objectively considered in the light of all the information developed in the function study and in the blasting and creating phases, and a suitable combination of alternatives is established for reliably accomplishing the total function at a cost lower than that existing.

The technique of using real creativity is based on the commonly accepted conviction that creativity, in lesser or greater degree, is a human trait.[13] By putting this trait into free play, a surprising number of ideas for the solution of problems can be generated.

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[13]Mandelkorn, R.S., Value Engineering Vol. 2, Elizabeth, N.J.: Engineering Publishers, p. 37.

It has been generally said that there are at least eight ways of doing practically everything, and people intent upon exercising their creative ability commonly hold this belief.[14] They recognize that creativity is not given a fair chance when a person becomes satisfied that a certain procedure is the only way. Therefore, they strive to keep away from merely criticizing a given solution and rather strive to weigh the other seven ways.

In value engineering, the application of available creative power is a potent reservoir to draw on as soon as the function desired in any particular case has been tied down to specifics. At this point, the question of foremost concern is: What else would do the function or in what other ways could it be reliably accomplished? The answer to that question needs to be established before hope can be had of sifting out the lowest-cost solution for optimum value. The most common obstacle to deriving results from attempts to be creative in developing ideas lies in the natural tendency to let judicial thinking interfere with mental explorations. For that reason, the main requirement in applying the creative technique is to stay away from being judicial in the first stage of the process. Another obstacle to getting creativity into action is the tendency to associate creative thinking with intricate and complex problems. The fact is that even the simplest problems benefit from being dealth with creatively. The thing to guard against here is the application of creativity in the wrong directions. A third cause of restricted use of creative thinking is often found in the difficulty people may experience in getting a chain reaction of ideas ignited and then sustained. In such instances, experience has indicated that a

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[14] Ibid., p. 38.

"brainstorm session" may work wonders. In the competitive atmosphere of such sessions, one individual's idea soon stimulates other ideas both in the mind of the individual himself and in the minds of his associates.

The purpose of the technique of identifying and overcoming roadblocks is to help prevent value work from so often stopping short of adopting accomplishable value alternatives. A roadblock, as that term is used in the value engineering sense, is a decision which prevents timely development of appropriate value alternatives.[15] The cause of it may be a lack of information, acceptance of wrong information, or a wrong belief. These factors cause the decision maker to decide that it is not wise for him to continue to work toward lower costs at the particular time. The sort of roadblock in question occurs after tests have shown that the performance objectives have been met. Value objectives, being less clear and not as measurable, are given secondary consideration, and decisions tend to be made to proceed with the drawing up of the designs, with the building of tools, and with manufacturing. It is important to bring roadblocks clearly into the open and to recognize that they usually represent the honest beliefs of the men who make the decisions. To achieve improved reliability, simplicity, and lower cost in these circumstances, more correct information must be injected into the situation with proper timing and presentation so that the decision maker will use it.

The technique of using industrial specialists to extend specialized knowledge is usually essential in penetrating roadblocks to achieve very much lower cost levels and very much higher value levels. To get top-grade value,

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[15]Miles, op. cit., p. 65.

it is essential that needed functions be clearly identified first. Then, the best available of industry specialists must be appraised of the function to the end that they contribute their knowledge and technique to the securing of the simplest, most reliable, and lowest-cost means for accomplishing these functions.

All products are developed to perform one or more main functions. The bicycle, the turbine generator, the airplane, and the baby's crib, for example, all serve principal functions for which they are purchased. Each main function, however, is accomplished by a group of subfunctions, each of which often has its own group of functional components.

Often, need has fostered development and has resulted in specific functional products such as special hinges, special rivets, special tapered structural shapes, and special gasoline-containing bags, to mention a few. The use of these products often provides a total function more reliably and more economically than specially designed components. When this is the case, design time and design cost are saved. Besides, proved products can be used without expending time or money for testing.

Available functional products commonly have low costs because the specialty supplier has a sufficient lead in his particular technology and sufficient manufacturing volume to produce reliable components most economically. This all sounds simple but practical circumstances and interfering factors combine to cause far too little use of available specialty functional products.

The technique of utilizing and paying for vendor's skill and knowledge yields exceptionally high returns when effectively used, for the following reasons:

> Large amounts of special knowledge exist in every field, and much of this knowledge is not possessed by people in other fields.
>
> Only a relatively small amount of the total special knowledge bearing on any technology exists in any one place at any one time.
>
> Special machines, fixtures, tooling, and equipment exists in large numbers.
>
> New developments known only to the engineers concerned with them are in progress in most good supplier's plants. They represent the best materials, processes, or parts to use "tomorrow" within the particular technology. They can be put to use only if the supplier is called into the job to which they are applicable.
>
> Suppliers want their new developments to follow actual needs in the market and they are usually searching for practical new ways of applying their technology. They benefit and the user benefits by working together.[16]

Generally speaking, all processes serve one of two purposes: (1) they accomplish functions that can be performed in no other way, and (2) they accomplish performed functions equally well but at much lower cost.[17] The second group takes in an extremely large number of processes which are of vital interest in value oriented work. All processes might further be divided into two classes: (1) processes which are known and are reasonably well understood by those who are making decisions, and (2) processes which are not known to the decision makers but which would be applicable and would accomplish the desired ends at very much lower costs.[18]

The capabilities of specialty processes to accomplish functions per dollar of expenditure extend far beyond what is normally recognized. Such recognition by professional people engaged in technical value-oriented work normally lags about three years behind capabilities. General recognition

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[16] Ibid., p. 91.

[17] Mandelkorn, op. cit., p. 10.

[18] Ibid., p. 15.

lags about ten years behind.[19]

Most specialty processes go hand in hand with the never-ending development of special tools. As a simple example, perhaps at some point in the history of industrial development three types of hammers exist: one for work with stone, one for the blacksmith, and one for the carpenter. As a variety of work was brought to the carpenter, the familiar claw hammer was developed to facilitate the nail-pulling process. Successively, this tool has been further developed into a heavier hammer for the process of laying oak flooring and a lighter and very much differently shaped hammer for tacks, with the still further development of the magnetic head to make the tacking process even more economical. Similar developments have taken place in hammers for metalworking and other fields. Probably few engineers know all the various stages of development of the simple hammer, each for the express purpose of improving a building or manufacturing operation of a specific type, and generally for the main purpose of improving value.

Application of the technique of utilizing specialty processes involves three steps:

1. Recognize the processes which would accomplish the desired functions for very much lower cost (a) may exist and not be known, (b) are being developed, or (c) would be developed if competent men in the technology knew of the need.

2. Put in motion actions which will increase the likelihood that specialty competence knows about, and becomes interested in, the needed functions.

3. Assign time and effort to stay with each item until the minor problems, minor objections, and minor misunderstandings which always arise in any new approach have been illuminated with useful and factual information. The aim here is to ensure that the results to be expected from the status of science

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[19]Miles, op. cit., p. 96.

> at the particular time will indeed be developed and made applicable to the particular project.[20]

To include the technique of utilizing applicable standards in the work guides of sophisticated industrial people sounds almost too elementary. It gives the impression of something amateurish. However, the full meaning here includes not only use of applicable standard parts and processes but appropriate utilization of parts of standard products, engineering concepts, manufacturing concepts, manufacturing processes, and materials. It means, also, do not use the standards that do not apply.

Knowledge of standards of all types is the basic ingredient around which all deviations for the benefit of value improvement must be organized. If cost and applicability data have not been developed with regard to the function required, the chances that the needed functions are being accomplished at near their lowest practicable cost are decreased considerably.

The matter of correctly selecting standards, non-standards, or partial standards in products, materials, or processes is similar to all other phases of decision making. The principal task is one of first locating sufficient applicable information and then making correct decisions within the various shades of gray. This will result in sometimes using standards, sometimes rejecting standards, and often using certain standardized functions but rejecting overall predigested standards.

It has been said that the system of value engineering concepts and techniques is organized and illuminated common sense.[21] Most certainly, any successful individual in the competitive economy has learned to use common

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[20] Ibid., p. 98.

[21] Garono, Louis E., "Payroll Engineering Versus Value Engineering", Armed Forces Management, May 1960, p. 31.

sense in applying the criterion, "Would I spend my money this way?" The average person, in evaluating his own expenditures, is often governed by the following conditions:

> He has a limited amount to spend
>
> He strives to secure maximum use function and appearance function from his expenditures.
>
> He expects to get such functions within reasonable limits in return for his expenditures. If that is not in view, he at once sets out to make appropriate changes or, at least, to do so when he again is ready to expend his funds.
>
> He knows that he cannot get reasonable value in exchange for his resources unless he has value alternatives clearly established and uses corresponding information as criteria in decision making.
>
> Before he spends his money, he will have clearly in view, the relative use values, the relative esteem values, and their relative costs.[22]

It was concluded earlier that in achieving value, it is vital to do what makes the best sense. Any deviation from the answers that make the best sense, results in either diminished performance or decreased value. Diminished performance can usually be identified by buying resistance. Even then, cause and effect are so separated that the particular answers which do not make good sense are not necessarily in clear view.

Both motivation and direction are provided by the effective use of the technique of value engineering. Unless the answers by design engineering, manufacturing engineering, purchasing, and management in all areas involved in decision making can affirmatively meet the test, "If it were my money, would I spend it this way?", it should be seriously questioned that a good degree of value exists.

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[22]Miles, op. cit., p. 104.

The present-day endeavor to establish systems which, almost regardless of people, will produce good results is certainly a most worthwhile trend. No matter how well a system is planned to take care of certain situations, there still remains room for the individual -- thinking clearly -- to make considerable contribution toward improvement. It is for that reason that the present technique is included in value engineering. Unless it is used and used effectively, experience in practical life shows that large amounts of identifiable unnecessary costs remain unidentified.

To sum up, value engineering, in a larger sense, is little more than a new name for an old concept -- that of greatest possible value in return for money expended. Efforts to improve the efficiency and simplicity of designs, search for new materials better suited to the purpose intended, experimentation with new processes -- all of these have long been recognized by engineers and sales personnel alike as goals.

Yet even if this concession is made, one outstanding fact remains, and this seems to be truly fundamental. The new element in value engineering is the emphasis on development of planned programs:

1. To emphasize particular aspects of value.
2. To coordinate efforts to achieve worthwhile objectives.
3. To maximize the results through proper supervision and direction.

CHAPTER II

NAVY'S VALUE ENGINEERING PROGRAM

The Navy's value engineering effort started as late as 1954.[23] As a result, the concept and knowledge of how to apply value engineering most effectively is still growing. The first entry into the field was by the Bureau of Ships which started with a Bureau office in the spring of 1954, and then expanded into the naval shipyards.

This initial value engineering effort was begun with five engineers and a senior officer placed in a staff position to the Chief of the Bureau. They were given a free hand to determine the course of the program. Their earliest effort was given to a study of a multiple boat procurement, and recommendations were made and accepted that resulted in a 15 percent savings on the total price. As this was applied to a 1000 boat procurement, the final result was a 3 million dollar saving. Some examples of these early attempts at value engineering were as follows:

1. Substitution of fir for mahogany plywood as applied to the inner and outer side and bottom planking. It saved half the cost and was preferred by the fleet for maintenance purposes. Savings were $224 per boat or $244,000 total.

2. Replacement of two copper nickel trapezoidal 90-gallon fuel tanks by four standard steel drums, plastic sprayed in the interior. The life of the boats in active service is about eight years and for this service life the steel tanks are suitable. Cost of $520 was reduced to $60 and a total of $460,000 saved.[24]

The difficulties of obtaining reliable cost figures from the Bureau level and in affecting, in any considered measure, the total budget became

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[23]Mandelkorn, R. S., Value Engineering Volume 2, Elizabeth, N.J.: Engineering Publishers, 1961, p. 104.

[24]Department of the Navy, NAVSHIPS 250-200, Bureau of Ship's Journal, February 1961, p. 26.

obvious during this initial study, and efforts were turned, in 1955, toward development of small staff units for value engineering at production and design points.

The working units of value engineers in the eleven naval shipyards were placed, with one exception, as a staff group under the head of the Design Division. These units of three to four value engineering specialists all had diversified experience in engineering, production, planning, and purchasing. Their ability to assume and maintain good relations in their day to day job with the remainder of the shipyard organization was a significant factor in their selection. Their work resulted in advice only for the line personnel directly assigned the responsibility for the item. The obtaining of line interest and positive consideration of their proposals was of utmost importance. It was soon learned that value engineers must have mobility in working across divisional levels and that their work products must command respect throughout the entire organization.

These value engineering specialists were trained specifically for their work by bureau seminars or by intensive sessions on the job by qualified value engineers. In the development of a project, the various value engineering techniques were employed within the overall scope of a standard analytical job plan.[25] The effort to keep red tape at a minimum was emphasized consistent with cross-fertilization of ideas. A standard project report card form was developed emphasizing simplicity and clarity. It provided a thumbnail sketch of the item as it was currently used and as it was proposed, together with appropriate reference to exact specification numbers and recommended re-wording

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[25]Department of the Navy, NAVSHIPS 250-200, Bureau of Ship's Journal, November 1961, p. 14.

where appropriate. Cost breakdowns and a listing of anticipated savings were also required. This form served as an effective description of the change either entirely on its own or accompanied by simple sketches, marked-up plans and such other information as may have been necessary to present a clear and complete picture for an eventual affirmative or negative decision.

The approved and accepted project cards were then circulated to other activities in the program for review and use where applicable. In developing a project, the value engineering specialists were trained to seek ideas from all areas and to insure that credit was given to those who contributed to these efforts. This program was not conceived to be a hermit operation of self-sufficient brain trusters, but very much a cooperative teamwork approach with full-time manpower available to function as a service unit.

The Bureau of Ships considered that the reports submitted were of high quality with all the facts and data needed for decision making without further research.[26] The value engineers included sketches of the item, as originally required and as proposed and if the specifications were affected, they recommended suitable substitutes describing in detail the functions originally furnished, the functions needed, and how to obtain them most suitably.

Private Shipbuilding Application

The spread of value engineering through private shipbuilding organizations, as might be expected, has been slow.[27] The Bureau of Ships has had to learn by experience the best way to do the job. This form of value engineering started at the end of 1956, in two private yards, and a year later four more

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[26]Schuler, James L., "Value Engineering Today", Bureau of Ships Journal, VI (February 1956) pp. 11-12.

[27]Mandelkorn, R. S., Value Engineering 1959, Elizabeth, N.J.: Engineering Publishers, 1960, p. 81.

were added. At the present time, there are some 55 ships under contracts with 13 shipyards. Two additional shipyards have been trained and will soon become part of the program. The first private yard to enter the value engineering program was the Electric Boat Division of General Dynamics, and in a little over two years of operation on nuclear submarine contracts with three specialists, they achieved savings of some three quarters of a million dollars.[28] In terms of dollar volume handled per year (averaging well over 100 million) this seems to be a relatively low savings effect. The acceptance rate on projects has been ninety-five percent and this indicates a gross failure in the program. There are not enough projects being submitted and not enough savings are being made on each project. In addition, there is pointed out the fact that the program of keeping a continuous flow of potential items for review from the entire yard is not adequate. Selection of the best return on which to work should conceivably result in items of $5000 savings or more per contract.[29] The recent spread of sharing savings to shipbuilders, an area covered in a later chapter, at the time of acceptance of a project makes it profitable to the contractor to work on items of common application and, of course, such items should always be profitable to the Bureau of Ships with its multiple applications.

The shipbuilder in fitting value engineering into his construction program, finds time is always a critical factor. "Crash program" is a phrase which has become all too familiar in military procurement. This lack of time was emphasized by the processing time needed for clearing a project once established through the shipbuilder's organization prior to submittal so that

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[28] Ibid., p. 80.

[29] Ibid., p. 81.

engineering, estimating, and production departments all got their chance to review it. The larger the organization, the longer is the time required. In addition was the time requirement for approval by the Bureau of Ships. This time lag averaged three months even with the monitoring efforts of the Bureau of Ships' value engineering staff to assist the technical man responsible for the item to understand the recommendations, obtain further information when needed and, in general, accelerate the progress of the project.[30] This problem has been partially solved by delegation of wide authority to the local supervisors of shipbuilding to authorize value engineering changes without prior Bureau approval.[31] Additional steps were taken internally in the Bureau of Ships with the hope that the value engineering projects, which must go through the Bureau for approval, will be handled more rapidly without undue disruption to other important work.

The time margin between individual plan completion and use in construction is expected to eliminate, in many cases, the consideration of certain unduly expensive elements of the designs. The answer to such problems would appear to lie in an attack during preliminary design or design stages. Efforts have been made, to a limited extent, to obtain this service from design agents and shipbuilders on a reimbursable price or fixed price basis with no incentive provisions. At the preliminary and contract design level in the Bureau of Ships, an active part-time value engineering group is at present engaged in making sure the value engineering projects have been reviewed and that the suitable ones are included in both ship and general specifications.[32]

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[30]Crouse, Robert L., "How It Works--Value Engineering in the Bureau of Ships", U.S. Naval Institute Proceedings, October 1959, pp. 152-156.

[31]Schuler, loc. cit.

[32]Department of the Navy, NAVSHIPS 250-200, Bureau of Ships Journal, X, (February 1961) p. 26.

The quality of value engineering projects has been a never-ending battle. The tendency it seems, is always to take a short cut and yet the value engineering program is not designed to sell on "raw ideas" with little, if any, substantiation, but is predicated on a complete job, requiring the most detailed questioning.[33] Value engineering projects have gradually built up at the Bureau level a reputation of being a service rather than a criticism, and as the evidence of the quality of value engineering projects becomes more pronounced, it seems that further reliance will be placed on future value engineering projects. At present, 90 to 95 percent of the projects from several of the participating private shipyards have been accepted.[34] Even in those yards with low acceptance rates, it is considered to be in the 50 percent bracket.

Value engineering effort is considered a part of the total team drive to produce or repair a ship. Since it represents savings in man hours and cost, it has to be important. Obviously, the Bureau of Ships has target dates for design and construction. These are not lightly established and every effort must be made to adhere to them. Any disruption on a shipbuilding program is a problem and can have an unknown time delay and cost effect when combined with a multitude of other disruptions. It is therefore emphasized by the Bureau that on every specific program an appropriate effort be made in the diversion of man-power to value engineering. The value engineering effort is planned to reduce cost and man-hours as feasible, without undue disruption to the construction program.

Experience to date has indicated that the number of projects which

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[33]Miles, op. cit., p. 5.

[34]Mandelkorn, op. cit., II, p. 105.

can be successfully completed on a given contract for ship construction without undue interference would result in a potential target of reduced cost of about 3 percent of the contract price.[35] If we assume an annual construction budget somewhere in excess of 1.2 billion dollars, this could mean a projected savings of somewhere near $36,000,000 or almost equal to the contract price of a nuclear submarine. A logical target to aim at for the effort has been set forth in the 3 to 5 percent range of effect.[36] This on a continuing basis should prove a most worthwhile effort.

Industry - Navy History

Turning now to the industry - Navy history of value engineering, the starting point was BUSHIPS contracts in 1955.[37] At that time, redesign service contracts were issued to several small boat designers for the design and prototyping of several boats. The goal was to be a value engineering design for each of the small craft. It was never applied in production, but estimates indicated a possibility of a 25 percent reduction resulting also in improvement in performance, lighter weight, higher speed, and greater dependability.[38]

In 1956, value engineering provisions were first inserted in shipbuilding contracts by the Bureau of Ships.[39] Originally these provisions required a number of persons employed full time in value engineering and a

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[35]Department of the Navy, NAVSHIPS 250-200, Bureau of Ships Journal, IX, (August 1960) p. 18.

[36]Ibid.

[37]Mandelkorn, R.S., "Value Engineering" (A paper presented to the Chesapeake Section of SNAME on 15 March 1956) /Washington, D.C., Bureau of Ships/ 1956.

[38]Roderick, M.D., "Value Engineering and Government", Value Engineering, I, (17 October 1960) p. 4.

[39]Mandelkorn, op. cit., II, p. 106.

provision for sharing the proceeds of their efforts -- 45 percent was to go to the contractor at that time. These provisions have been subjected to continuing revision. At present, there is no requirement for a specific number of employees and the current provision establishes 50 percent sharing on the part of the contractor. Today, there are 34 contracts covering 55 ships and 13 builders which include value engineering provisions.[40]

In 1957, the Bureau of Ships first apprached ships' equipment producers with value engineering contracts language. The first such contract with Solar Aircraft Company involved a developmental gas turbine driven source of low pressure air for shipboard pneumatic systems.[41] The Bureau of Ships learned a lesson best expressed in the words of the contractor, "Several factors combined to limit the cost reduction potential -- low volume, short term delivery, and inadequate lead time for value engineering."[42]

Other Areas of Application

The search for more productive methods in contract areas of greater financial potential led to effort in selected electronic equipment contracts in 1958. Shipbuilders themselves buy a large quantity of equipment and the Bureau of Ships has urged them to establish a firm figure for sharing savings with their vendors for the ideas they submit. There seems to be evidence that some of the builders intend to do this by including a simple agreement as part of their sub-contract in the near future.

The private ship repair business under Navy's contract would appear

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[40]Roderick, op. cit.

[41]Mandelkorn, op. cit., II, p. 107.

[42]Mandelkorn, op. cit., II, p. 105.

to offer another likely area, except that the time limitations are severe and reliable advance information for planning is often not satisfactory. The Bureau of Ships expects to apply value engineering in this area with private shipbuilders under industrial manager supervision in the very near future.[43]

Other Navy Bureau Applications

The Bureau of Naval Weapons followed somewhat the same pattern as the Bureau of Ships, with initial efforts in their field such as naval ordnance production activities. For example, the Naval Ordnance Plant, Louisville, achieved a $350,000 cost reduction to date for the torpedo tube Mark 32.[44] Steps are now being taken to introduce value engineering functions at all major R & D field activities of BUWEPS.[45]

The Military Sea Transportation Service designated a value engineering coordinator early in 1957. He operates in cooperation with his counterparts in the Bureau of Ships and the Maritime Administration.

Many supply-type activities have formal value engineering programs. Among these are the Ships Parts Control Center, the Electronic Supply Office, and the General Stores Supply Office. Although these activities are under the management control of the Bureau of Supplies and Accounts, they work with the supply departments and the value engineers of the Naval Shipyards. The Bureau of Supplies and Accounts has other programs which employ the value engineering philosophy. The Stock Coordination Division of the Bureau strives to reduce redundancy in the supply system. When it finds functionally-equivalent

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[43]Roderick, op. cit.

[44]Personal Interview with William R. Feichtinger, Chief, Value Engineering Branch, Bureau of Naval Weapons, Washington, D.C., March 1961.

[45]Ibid.

hardware under several stock numbers, it takes action to combine the items. Lower costs result because (1) fewer items are carried in the supply system, and (2) larger discounts apply to the larger-quantity purchases which then become possible.[46] Noting functionally-equivalent hardware carried under different stock numbers is a most important way in which people in supply activities apply value engineering techniques to their work.

The past shows that both within naval activities and Navy-contractor relationships, value engineering has proved to be a profitable tool. The present shows that there is a need for the application of value thinking, and specifically, value engineering in more fields. In the future, from the Navy standpoint, there must be a continuation of effort to provide for value engineering services in worthwhile developmental contracts. There must be increasing use of target cost provisions in combination development-production contracts where redetermination provisions are involved. There must be continuing use of cost reduction and sharing provisions in Bureau of Ships fixed-price contracts and there probably will be increasing usage of this type of contract relationship by other bureaus and field activities, since this now has the blessing of the Office of Naval Material. There should be active encouragement of voluntary effort by contractors, particularly in development areas where there appears to be the potential of the greatest effect.

Value engineering has become the official policy of the Navy as expressed in the Office of Naval Material Instruction 4858.1 of 19 July 1960.[47] This instruction was not intended to suggest that value engineering people

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[46]Department of the Navy, NAVSHIPS 250-200, Bureau of Ship's Journal, IX, (January 1960), p. 2.

[47]ONM Instruction 4858.1 of 19 July 1960 (Office of Naval Material) Subj: Value Engineering Program; policy concerning.

could solve the problem of reducing costs by increasing their individual efforts, but rather to urge all levels of management to increase their familiarity with the need for value engineering, what it offers, and how it can be utilized throughout the Navy by individuals who are concerned directly or indirectly with design and procurement of material.

From this discussion, it seems apparent that value engineering techniques are being used by the Navy in many situations. The Department of the Navy is populated with military and federal employees who strive to reduce costs each and every day. Whether they work in a formal program or merely help each other informally in their day-to-day work, they are trying to cut costs.

It should be apparent that the techniques of value engineering are universal in their application. As they are properly used by all the people in the Navy, as well as by many others in government and in industry, these techniques will invariably help the Navy get more for its money.

CHAPTER III

DEPARTMENT OF DEFENSE VALUE ENGINEERING PROGRAM

> The Army, Air Force and the Navy are tearing their shirts implementing value engineering programs in their installations and those of their contractors, but not so the Department of Defense.[48]

It is highly presumptuous for anyone to attempt to report definitively on the status of value engineering in the Department of Defense. The best anyone can hope to do is to report on what he reads or observes from where he stands. No one is in a position to stand on a summit and take a 360-degree look either at value engineering, or even at the Department of Defense. Value engineering cuts across research, development, production, maintenance, procurement, storage, and many other areas, and the Department of Defense is literally the most gigantic organization in the world.[49]

This chapter, however, is about the status of value engineering in the Department of Defense. If an attempt were made to answer the question, "What is the status of value engineering in the DOD?", the answer in terms of policies published by the DOD, or more correctly, the Office of the Secretary of Defense, might be as follows: Value engineering has the status of a freshman at George Washington University, it has to prove itself. This does not mean that value engineering is not well established in various bureaus and commands of the Army, Navy, and Air Force, as was discussed in Chapter II. It simply means that in terms of established policy, from the great white father so to speak, value engineering has not yet been accepted.

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[48] O'Connell, E. T. "Editor's Notes," Value Engineering Weekly, Vol. 2 (July 24, 1961), p. 1.

[49] Mandelkorn, R. S. Value Engineering Vol. 2, Elizabeth, N. J.: Engineering Publishers, p. 87.

It is to be expected that the Department of Defense, as always, will probably take a long hard look at value engineering as well as at other emerging fields of technology before it rushes into print with an endorsement. The Department of Defense, it seems, has always felt that such action is simply a matter of good judgment and good management.

At the present time thate is only one statement among the various documents issued by the Department of Defense which pertains to value engineering. This is the Armed Services Procurement Regulations, Section 3-406.3, which defines value engineering and states that value engineering incentive contracts are suitable for items covered by firm government specifications. It reads as follows:

> 3-406.3 Contracts with Value Engineering Incentives.
>
> (a) Description. Value engineering incentive provisions may either require or encourage the contractor to maintain a staff devoting time and effort to value engineering studies to reduce costs under the contract in return for which the contractor receives a stated percentage of the resulting savings. A "value engineering study" is an intensive appraisal of all the elements of the design, manufacture or construction, procurement, inspection, installation, and maintenance of an item and its components, including the applicable specifications and operational requirements, in order to achieve the necessary performance, maintainability, and reliability of the item at minimum cost. The purpose of value engineering is to make certain that every element of cost (e.g., labor, material, supplies, styling, and services) contributes proportionately to the function of the item. The government shall make reasonable efforts to expedite the analysis of each study submitted by the contractor. Where a change recommended by a study is adopted, a change order is issued under the changes clause, together with a reduction in the contract price corresponding to the agreed percentage of the cost reduction. The government does not have to adopt any study and failure to do so is not subject to the Disputes clause of the contract.
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> (b) Applicability. Value engineering incentive provisions are suitable primarily where the items being procured are covered by firm government specifications.[50]

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[50]U.S., Department of Defense, Armed Services Procurement Regulations, Section 3-406.3 Washington: Government Printing Office.

This provision of The Armed Services Procurement Regulations seems to be a very incomplete coverage inasmuch as the real and true applicability of value engineering should not be limited only to items that are covered by firm government specifications.

In the present era of missiles and space vehicles, it seems reasonable to expect that value engineering may find its greatest opportunities in terms not covered by firm specifications. As progress is made into evaluation of increasingly complex equipment, it can be expected that it will become more and more difficult to write definitive specifications. With greater scientific progress, "firmness" of specifications seems hardly a virtue. The crucial problem of specification writing has always been in the preparation of a document which defines minimum requirements and includes built-in responsiveness and adaptability to change.[51]

It seems noteworthy that the Armed Services Procurement Regulations simply states that value engineering incentive provisions are "suitable" for items covered by firm government specifications. It has not been interpreted to forbid value engineering contracts for items not covered by such specifications. In fact, value engineering is being accomplished on items for which firm and definitive specifications are not practicable.[52] Usually, however, in such instances value engineering is included as an element of a broader function (design or production engineering) and is not of the incentive type. It is important here to distinguish between contracts for value engineering with and without incentives. Because incentives are omitted, there is no

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[51]Mandelkorn, R.S. "Who Needs Value Engineering?," Armed Forces Management, Vol. 5 (February 1959), p. 21.

[52]Ad Hoc Study Group on Parts Specification Management for Reliability, ODDR & E and OASD (S&L), May 1960.

reason to assume that the effectiveness and motivation of value engineering is compromised.

The fact that value engineering has received but limited recognition from the Department of Defense would seem to indicate that value engineering may well be at a crossroad within that department. It must soon establish itself as a key function or simply as one specialized tool among many others. The latter status is not to be bemoaned. But if value engineering is a key building block of management, then the case has yet to be made to the satisfaction of top management in the Department of Defense. If it is made, it will have to be by hard, fundamental study and research. If and when such a case is made, the Department of Defense undoubtedly will, at some future date, publish official policy (apart from ASPR) giving value engineering the recognition it is now seeking.

In the meantime, top management in the Department of Defense, as well as in industry, has a difficult problem in attempting to assimilate into existing organization the many new concepts, techniques and tools, choose what label you wish, which are constantly coming on the scene. Reliability, quality control, standardization, operations research, specification analysis, maintainability, and other subjects are some of the new fields of engineering that have only recently cropped up. These fields frequently do not fit into any of the traditional organizational blocks. Nor do they seem to be of such central importance that they justify autonomy alalogous to a Department of Electrical Engineering at a university or to such traditional functions as research or production. Value engineering is what the academician may well label "interdisciplinary." At one time the Department of Defense attempted to accommodate these newer fields by establishing an office for applications

engineering. This apparently did not work out.[53] It would seem that those people who find themselves in the interdisciplinary fields, who draw on all branches of mathematics, science, engineering, economics, and industrial administration, might formulate for management an engineering-industrial concept that makes possible the assimilation of new fields without compromising the effectiveness of older fields that have borne the heat and burden of previous trials. If this is not done, many of these new ideas might well cancel each other out in competition for top management's attention.

Many of these fields could well be incorporated into a single staff organization which might carry a title of, "Technical Policy and Development" or some other similar name. Such a group could develop ideas and tailor them to satisfy existing needs within the present organizational pattern. But the implementation of these new ideas and techniques would be applied, in part, by production and, in part, by design. Likewise, value engineering would be represented where it could do the most good, e.g., within design, within maintenance, or within production. Such an organization would give these functions the identity and independence they need. But most important, it would promote harmony between the "old" and the "new." The time has come when each of us has to stand back for a moment and re-examine our relationship with the other people down the hall.

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[53] Mandelkorn, op. cit., II, p. 94.

CHAPTER IV

CONTRACTING FOR VALUE ENGINEERING

> If value engineering techniques can gain Navy-wide acceptance and management support at every level, significant improvement in material procurement should result.[54]

It is fairly safe to say that the field of contracting is one facet of the value engineering program which has been little discussed and understood. While contracting has managed to satisfy the varied needs of value engineering, the contracting art has not kept pace with or achieved the refinements credited to other elements or facets of the value engineering program. During the relatively short period of time during which value engineering has risen to its present acceptance, both industry and the military services have worked out in many areas, suitable contractual arrangements tailored to meet specific needs. The Bureau of Ships, as briefly discussed in Chapter II, pioneered this effort in both the shipbuilding and ship equipment fields. With the spread of the value engineering program to other segments of the military services, they, too, are being required to make contributions in the contracting area.

While it is recognized that independent pursuance by each service of an endeavor sometimes produces varied ideas and results, the military seems to velieve that its approach to contracting for value engineering should be pretty much the same. This approach is based on the premise that the greatest amount of savings to the government can be obtained by providing realistic and attractive incentives to contractors as an inducement for initiating vigorous value engineering programs. Value engineering, in one form or

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[54]Milne, C. P., Assistant Secretary of the Navy (Material), in a memorandum to Chiefs of all Navy Bureaus, 20 July 1960.

another, has application to contracts providing for development, production, or any variation thereof. Once it has been decided where to place the effort, there are several different ways in which value engineering can be accomplished.

Perhaps, the first real breakthrough in contracting for value engineering in the military services can be attributed to a few Bureau of Ships contracts with private shipbuilders.[55] A little time later, value engineering contracting was started in the equipment field. Basically, the approach was to give the contractor time to value engineer the ship or equipment he had contracted to produce, before he produced it. He was paid for this effort, and later on in the contract, he was permitted to retain a prescribed percentage of the dollars he could save on value engineering proposals approved by the contracting officer. This contractual device, which has been tried and administered with appreciable success, has provided the military services with experience and know-how. It has also served as a basis for the formulation of new and fresh approaches in the programs of Army Ordnance, and the Bureau of Weapons.[56]

In taking a close look at the contractual techniques and arrangements which have been conceived by the various segments of the military services, it is apparent that they can be reduced to two basic approaches.[57]

First, a contract provision establishes value engineering as a line item in a contract, at an agreed price, at the outset of the contract. Under this type of arrangement, the contractor does not share in any savings

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[55]Roderick, op. cit.

[56]R. L. Crossman, "Military Concepts of Contracting for Value Engineering", Value Engineering Weekly, I, (12 December 1960), p. 1.

[57]Ibid.

generated, but receives compensation for the effort expended, regardless of whether or not proposed cost savings suggestions are adopted. Generally, this approach is adaptable to procurements of Research and Development or an evaluation nature, and serves as a supplemental undertaking to the development project. By incorporating value engineering in the design and development phase, it is believed that cost reduction can be accomplished in the initial stages before the item goes into mass production, thus making possible the savings of substantial dollars. The objectives here are to reduce cost to the barest minimum by applying a high order of cost prevention and cost reduction effort to the equipment without sacrificing any of its essential functions; and to guide the planning for the development of the equipment toward obtaining a minimum cost for ensuing production phases.

The second, and perhaps the most popular contractual approach adopted by the military services, provides for the contractor to engage in a value engineering endeavor under a contract in exchange for a share in the savings generated by value engineering proposals adopted by the contracting officer. Under this procedure the contractor receives an incentive compensation based on value engineering proposals accepted by the government. Primarily, this method has application to production type procurements. In its operation, the contractor submits value engineering proposals, usggesting modifications to specifications and designs requiring contracting officer approval, which will result in less costly articles without adversely affecting the function, quality, and reliability of such articles. Compensation to the contractor is derived by a percentage share determined at the outset of the contract; this is applied against the cost savings negotiated under each value engineering proposal adopted.

This latter method gives consideration to benefits to be derived by the military in terms of cost reduction of equipment, and the benefits to be gained by industry. Industry benefits essentially by cost reduction of products which tends to make them salable to the military, and by sharing in the savings effected.

With respect to the first method the extent of the value engineering effort expended can be determined readily in advance and therefore can be incorporated in most approved types of contracts. However, since Research and Development programs normally are covered by cost type contracts, the most likely area for this approach would be in the cost contract.

In considering the second method, under which the contractor receives a share of the cost savings effected through his value engineering efforts, it was found that this procedure was not as readily adaptable to all type contracts as the former method.

Investigation revealed that firm fixed-price contracts were the most suitable.[58] This is due to the ease of application of contractual terms necessary to determine the award of a share of the savings.

Fixed-price incentive contracts, on the other hand, already have cost reduction features built in through the sharing of savings derived from efficient production methods and techniques and related cost reduction efforts, which result in reduced costs of the programs. Therefore, problems have been encountered in the implementation of this approach to the incentive contract without interfering with the sharing arrangements already incorporated in the contract. Further investigation, however, revealed that there are other

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[58]Mandelkorn, op. cit., I., p. 99.

areas susceptible to cost reduction under the incentive type contract which would not disturb the incentive sharing arrangement already established. In essence, the mechanics of establishing a percentage of share, and the determination of the cost savings, are the same as those employed in the firm fixed-price contract. In separating this type of incentive share arrangement from the normal incentive formula, the contractor's share of savings is set aside as additional compensation outside of the operation of the incentive clause, and is not subject to price redetermination.

In the initial consideration of applying the incentive share arrangement to letter contracts, some reservations were made regarding contractual practicability of its use, because of the unknown elements inherently associated with this type of contractual vehicle.[59] However, since many major procurements under letter contracts are susceptible of value engineering, unless such a program is instituted at the inception of a contract, substantial cost savings may be bypassed. Further study of letter contract application was undertaken and resulted in the establishing of proper contractual language for letter contracts.[60]

The only area in which the incentive share arrangement does not appear to have application is int the cost type contract. This stems from the fact that difficulties may be encountered in determining whether or not a cost savings has actually been effected, particularly in cases where cost overruns are involved. Therefore, at the present time consideration is not being given this method for use in cost type contracts.

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[59] Ibid.

[60] R. E. Dixon, "Value Analysis and the Navy's Air Weapons," Armed Forces Management, VI, (October 1959), pp. 18-19.

Contracting for Value Engineering from the Business Viewpoint

The military purchases from private industry, the Research and Development and the hardware that it needs on a business basis. Business operates within the same framework as it does for its non-defense business. It is providing Research and Development and hardware, and in turn receiving financial compensation. This compensation does a two-fold job: (1) it bears the costs of salaries, materials, and the overhead of people doing the job and (2) it provides a profit, and this profit is the major reason for which business exist.[61] The amount of profit to be derived frequently determines whether the investor is going to put his capital into real estate, the bank, or the electromechanical business. It often determines whether a company will make missile controls or wrist watches. On the other hand, the military's motivation in this business must naturally be to get the most possible at the lowest possible cost. There should be enough potential in value engineering to motivate both industry through better profits, and the military through lower costs.

For best results, a contract provision or clause specified by the military is highly desirable, the main reason being that, if the military sponsors the effort, it will be prone to investigate thoroughly all value recommendations. From the military point of view, low cost is a motive -- a low cost on this particular contract, with value engineered product features that will continue to be applied in follow-on orders for the product.

From the industry point of view, the profit picture is jeopardized by this provision, even though the contract provisions include the cost of

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[61]Mandelkorn, op. cit., I., p. 29.

the value engineering effort. The reason is that a particular company has no assurance that it will receive follow-on orders to a current order. A frequent situation is that the follow-on orders including the results of value engineering, will go to a competitor or perhaps to a government production facility.[62] These actually are the people who capitalize on the value engineering effort already performed by another contractor. And when one considers that many of these value improvements involve the use of small specialty suppliers, or unique processes, the revelation of such information to competition can substantially affect a supplier's market position on a particular product line.

These are real costs, although they are indeterminable. On this basis, some compensation seems due to industry, and on a practical basis, some incentive is needed to get the value engineering job done as well as it should be done. Some good solutions have been worked out. One that would appear to satisfy both the military motive for lower cost and industry's for better profits is an incentive arrangement whereby the savings from the value engineering effort are shared by both the military and industry; a 60/40 split has been accepted as fair, with 60 percent of the savings going to the military and 40 percent to the contractor.[63] The military still realizes 100 percent of the savings on follow-on orders, yet industry receives compensation for compromising its position.

Firm-price contracts are the area in which value engineering has been contracted for most frequently. There are many complex considerations involved in applying value engineering to CPFF contracts and in contracting for value

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[62]Mandelkorn, op. cit., II, p. 65.

[63]Mandelkorn, op. cit., I, p. 30.

engineering to be applied to a particular product independent of production

Although the compensation considerations of value engineering have received the greatest emphasis, this does not mean that there are not other important considerations associated with such contract provisions. Value work requires specially trained people -- professionals in the field. A well functioning value organization must have extensive vendor files and access to advanced engineering and manufacturing information. There would seem to be a lot of missionary work still to do for value engineering throughout industry. In spite of the tremendous payoff, for many small companies the initial investment in value engineering talent and facilities poses a problem. But for those who are willing to accept a risk, the opportunity seems very great. It would not be accurate to say at this time that if value engineering were specified in all firm-price contracts, it could be done. It might not be practically possible, but it certainly would be desirable. The fact that this tool is so useful in meeting the military needs and improving industry profits, leads to the conclusion that value engineering will be as necessary for successful business operations as any other kind of engineering.

Another consideration is in the interest of the customer getting his money's worth from his investment in value engineering. It is human frailty to allow the least amount of time for those areas in which the most effective work can be done. In value engineering, it takes time to evaluate designs, contact vendors, test new processes, etc. Unless the customer provides a reasonable amount of time for doing value engineering, he will not realize its potential. On the other, if ample time is allowed, the results will usually be substantial.

Another consideration that will affect the success of a value

engineering clause, is how familiar the customer's technical reviewing people are with value engineering and what it is trying to do. If they have been exposed to the value approach, then the mountain of recommended changes have meaning. If not, there is the possibility that those recommendations will carry a nuisance connotation and be passed over without serious consideration. Again, here is a matter for military-industry cooperation, and such matters, while they must be considered, can usually be satisfactorily worked out.

Value engineering has been blessed by the Armed Services Procurement Regulations, as witnessed in Section 45, and the re-negotiation board has agreed to consider contractor profits derived from value engineering clauses.[64]

Value contracting is still a relatively new business. Yet, it is thought that the success of value contracting lies in satisfying the customer's objective of low cost and the contractor's objective of profit. Any arrangement that neglects either of these aspects most certainly will cripple progress.

As with any contractual clause, the ability of the seller to provide the service is an important consideration, especially since professional value people are highly trained people with considerable experience in industry. Adequate time must be allowed to do the job and all reviewing authorities must have an understanding of the value approach. In the contract area, there is a challenge to devise more and better provisions for using possible savings to satisfy both the profit objectives of industry and the economy objective of the military.

A number of lessons have been learned from experience with value engineering contractual relationships. Some of these have been set forth

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[64]U.S., Department of Defense, Armed Services Procurement Regulations, Section 3-406.3.

as follows:

1. The cost reduction and sharing type of clause has been the most fruitful area.

2. There must be provision to provide an incentive for contractors to introduce approved proposals into production.

3. In contracts involving production runs, the time period for value engineering services must be confined to the early part of the total contract period to be effective.

4. On short run items it is not profitable to insert a requirement for value engineering services after a contractor has started physical work.

5. Contract for value engineering redesign services only where it is clearly demonstrable that follow-on production of equipment is certain.

6. Specify contractually, the due dates for proposals. Conversely, action must be speeded up on proposals which are submitted.

7. Value engineering proposals must be submitted with sufficient facts and cost figures to clearly show the advantages of the idea.

8. Enter in a service-type contract for value engineering only with those concerns who actually have a demonstrated capability.[65]

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[65]Department of the Navy, NAVSHIPS 250-200, Bureau of Ship's Journal, February 1961, p. 27.

CHAPTER V

VALUE ENGINEERING AND THE FUTURE

> ...if we are to produce the most effective weapons systems to provide adequate defense against the charging threat which faces the country, we must be much more precise and deliberate in our planning, our programming, and our allocation of resources than we have been in the past. We cannot afford to make guesses where our guesses involve critical weapons systems and the commitment of tremendous resources. Both the Secretary of Defense and the Assistant Secretary of Defense (Comptroller), Mr. Hitch, have made it very clear that they are abundantly aware of this problem.[66]

The recent acceptance of the value engineering technique can be attributed to a fundamental change in the relative availability of material and manpower resources among the major powers. No longer can the United States count on a superiority in resources to gain and advantage over highly militarized adversaries. Today our welfare and that of our children may well depend on the scientific utilization of limited resources.

Militarily, the United States must provide better weapons per pound of weight, better weapons per cubic foot of occupied space, and better weapons per man/month of design, development, manufacture, service, and maintenance.

Mankind may yet succeed in not using these weapons, limiting war to the economic arena. This would call for even more and better production. Certainly, our competitors in the east are trying to squeeze the greatest possible yield from their resources, yet we can obtain an even greater yield from ours, provided we exploit these four advantages:

1. A diversified scientific community, arising from a cultural background of great depth and breadth.

2. A broad-front technology, uniformly advanced in most phases of human endeavor.

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[66]Frank A. Bogard, Comptroller of the Air Force, "Some Ways to Achieve Economy in National Defense", Value Engineering Weekly, Vol. 2, (May 8, 1961).

3. Freedom from doctrinal constrainists in military and industrial planning.

4. A mechanism for scientific, unemotional self-appraisal at a national and international level.[67]

The Western Alliance would seem to have the means to evaluate its capabilities and limitations. Born out of interdiscipline, scientific cooperation in World War II, Operations Research proved its value, at the darkest hour in the Battle of Britain, with surprisingly quick results. (400% increase in the destruction of U-boats - 65% decrease in merchant ship losses - 20% increase in enemy aircraft interceptions.)[68]

Today, our armed forces are availing themselves of operations research and of every other scientific technique that can give the United States an advantage. Value engineering is such a technique. While operations research is a general method for prividing management with a scientific basis for the solution of executive problems,[69] value engineering functions in the more limited area of weighing, comparing, and balancing the desirable characteristics of a product, or program, in order to achieve optimum balance of these characteristics at minimum cost in available resources.[70]

Like the calculus, value engineering has developed in two different areas at the same time. In the same way that Newtonian fluxions vied with the Biebnits notation which is used today, value engineering's practical

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[67]Carlos Fallon, Administrator of Value Engineering, Missile and Surface Radar Division, Radio Corporation of America. A paper read to the I.R.E. Product Engineering and Production Converence on 19 June 1961.

[68]Victor Lazzaro, Systems and Procedures. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1959.

[69]C.C. Herrmann and J.F. Magee, "Operations Research for Management," Harvard Business Review, Vol. 31 (July-August 1953), p. 100.

[70]L. D. Miles, "You Can Slash Costs by 25 percent with Value Analysis," Management Methods, Vol. 14 (June 1958), p. 46.

common-sense terminology vies with the more mathematical and bookish terminology of the "scientific" school.[71] It is concrete, directed toward a major, but special phase of a problem: it seeks to minimize dollar cost without impairment of necessary function. Thus, value engineering came into being as a tool for implementing the change of policy from an outpouring of plentiful resources to the balanced utilization of limited resources.

This branch of operations research concerned with achieving optimum balance of desirable characteristics at minimum cost in resources has been active since World War II. The question that may easily come to mind, is "Where was this branch of operations research when our priceless resources were being poured down the drain?" It was there, alright, helping pour - but not down the drain. It was saturating the enemy's anti-aircraft defenses so that his air fields and industrial plants could be destroyed; it was putting blimps and corvettes on the tail of every submarine wolf pack regardless of dollar cost. The most priceless of our recources was time -- time to develop radar, time to develop sonar, time for Britain to catch her breath and prepare for the assault. Operations research recommended that we trade industrial production for time, sending five bombers for every fighter the Germans could put in the air, and five ships for every torpedo they could put in the water.[72]

This was the scientific value engineering of yesterday. It maximized the expenditure of dollars, and the resources they represented, so the United States could overwhelm the enemy with our preponderance of resources. It is also the scientific value engineering which today is saving dollars, because dollars, and the resources they represent are scarce by comparison with the

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[71]Fallon, op. cit.

[72]Ibid.

demands of our defense system. But even today, it may maximize dollar-cost to minimize weight, or volume, or the elapsed time required to design and develop.

This may well be the value engineering of tomorrow - a generalized, abstract technique of universal application. Its tools consist of the mathematical techniques of operations research:

> Mathematical statistics, decision theory, Monte Carlo methods
>
> Probability, logic, set theory, queuing theory
>
> Matrix theory, linear algebra
>
> Calculus, numerical analysis[73]

None of the above are particularly sophisticated at the level used in value engineering, nor is it necessary to dominate a great variety of manipulative techniques in each field.

The application of the precise techniques of science and engineering to the areas of evaluation, programming, and decision making which have heretofore been governed by intuition, must increase the strength of our nation by multiplying the usefulness of its resources. Then, not only can the free peoples of the world forge ahead of regimented states, but together they can call the tune. They can exploit the wide, rich, and continuous vein of culture from which their diversified sciences spring and they can gain much from free cooperation among the diverse disciplines.

The free peoples can use operations research and value engineering primarily to ensure intellectual honesty and a rational approach to reality, and secondarily, as techniques to weigh specific choices. Without doctrinal constraints in thought or action, they can mobilize their advanced technology

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[73]Lazzaro, op. cit., pp. 408-414.

to make peace the only feasible course of action for our contenders.

Perhaps a key concern for the future of this technique is the growth of lip service in value engineering, both in the government and in industry. Much of the political atmosphere has caused the growth of activities designated as value engineering with very little foundation to support an effective program which utilizes the fundamental concepts of value engineering. Certainly while any increased effort to bring attention to cost and the reduction of cost is worthwhile, it is a sad mistake to apply the term, value engineering, to just any cost reduction, teamwork or other activity aimed at reducing product cost. Superficial programs of this type will do little more than scrape off some of the cost cream that exists in products and will come a long way from achieving any significant gain in the number of weapons or amount of material which the government can buy for the same amount of money.

In the promotion of value engineering, there must be a constant effort to highlight the fact that these words identify a specific package of techniques and approach which must be competently utilized in order to achieve the greatest benefits. One of the greatest needs in the value engineering field seems to be an understanding by management as to what type of individual can successfully carry on a value engineering program and what type of training and experience he should have in order to carry out his responsibilities.[74] One of these should be a depth of understanding, experience and practice of assigning true value levels or value standards to the various functions required within products. Too many of those using the words, value engineering, think of this only as a new device, process or vendor search, possibly coupled with minor

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[74]J. J. Hibbitts, "Value Analysis is a Continuing Job," Purchasing, Vol. 48 (29 February 1960), p. 85.

design modifications which open tolerances, specifications or requirements.

A great need for this technique is that of attracting high level, competent people into the field; but this cannot be expected to come about until the value engineering gains management acceptance and more stature within the government and business world. It is a situation of "which comes first, the chicken or the egg?" in that it is difficult to gain acceptance for an activity without having some competence within the activity to generate that acceptance. The type of person who can initiate and carry through an effective value engineering program, quite likely is the same type of person who can effectively manage a business and vice versa.

Value engineering is coming of age. In the hands of experienced product engineers it should grow into a truly professional tool for improving the competitive position of a company. It applies the precise techniques of science and engineering to those areas of evaluation, programming, and decision-making which have heretofore been governed by intuition. In estimating, bidding and scheduling, value engineering saves not only money but also elapsed time. In design, development and production, it seeks the best ratio between desirabel qualities and their cost in available resources.

Whatever else it is, and in actual practice it is many things to many people, value engineering is not mysterious. If there ever was a technique that seems to be baisc, factual, practical, and down to earth, yet one that permits and calls for the fullest employment of the human imagination, it is value engineering when it is practiced as it should be.

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